WOUND DRESSING FOR UNCONTROLLED BLOOD LOSS –BY POLYELCTROLYTIC COMPLEX

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE

REQUIREMENTS FOR THE DEGREE OF

Bachelor of Technology

in

Biomedical

by

GOURAV KUMAR BEHERA
Roll no-111BM0003

Under the guidance of

Prof. DEVENDRA VERMA

Department of Biotechnology and Medical Engineering

National Institute of Technology, Rourkela

2015

NATIONAL INSTITUTE OF TECHNOLOGY

ROURKELA

C E R T I F I C A T E

This is to certify that the thesis entitled *"***Wound dressing for uncontrolled blood loss by Polyelectrolytic complex***"* submitted by **GOURAV KUMAR BEHERA**[Roll No. 111BM0003] in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Biomedical at National Institute of Technology, Rourkela is an authentic work carried out by her under my guidance.

To the best of my knowledge the matter embodied in the thesis has not been submitted to any other University/Institute for the award of any degree or diploma.

Date:

Prof. DevendraVerma

Department of Biotechnology and Medical Engineering

National Institute of Technology

Rourkela-769008

A C K N O W L E D G E M E N T

I avail this opportunity to extend my sincere appreciation and gratitude to my guide Prof. Devendra Verma , Biotechnology and Medical Engineering Department, for his invaluable academic and professional guidance, constant encouragement and kind help at different stages for the execution of this project.

Gourav Kumar Behera
111BM0003
Department Of Biotechnology and Medical Engineering
NIT Rourkela.

ABSTRACT

Hemostatic dressing techniques have been developed for advanced hemorrhage control wound dressings and systems for utilizing and delivering the same for different wound healing purposes. The subject wound dressing is built from a non-mammalian material for controlling severe bleeding. The wound dressing techniques that we have carried out by taking the materials such as chitosan, sodium alginate and calcium chloride. Since wound healing is a complex process which involves the working of both the circulatory system and the immune system. The main objective of developing this wound dressing techniques is to accelerate the process of healing the wounds. The ideal characteristics that a wound dressing should have are to provide a moist environment, to absorb wound fluids, protect from microbial infections and most importantly should be bio-compatible .In the current study we developed the gels with different concentrations of chitosan, sodium alginate and calcium chloride, also the gels prepared were analyzed by different characterization techniques such as scanning electron microscopy(SEM) and Fourier transform infrared (FTIR) spectroscopy. The different samples of the gels were also subjected to viscosity test. For the homogeneous mixing of the solutions of chitosan plus calcium chloride mixture with the sodium alginate solution we have designed a prototype such as a dynamic syringe mixture which serves as a convenient platform for applying the gel formed on the wound for the wound healing. From the above experiments carried out by us concludes that for the gel to be formed and for its application as a wound dressing proper mixing should be allowed and the prototype designed by us minimizes the time of formation of the gel when the solutions are mixed and serves as platform for the application near the wound healing.

CONTENTS

CHAPTER 1

INTRODUCTION

INTRODUCTION:-

Hemostatic dressing techniques are developed for advanced hemorrhage management wound dressing and systems for utilizing and delivering constant for various wound healing functions. Wound might be a condition of the skin where in its ancient structural integrity is broken attributable to mechanical including chemical and physical interrelation of body with the external atmosphere. The process of wound dressing basically involves four stages which are physiological condition, inflammation point, proliferation and last one is remodeling. Wound dressings unit medical devices that unit accustomed enhance the speed at that wound healing technique happens. Wound dressings ought to ideally have characteristics like maintenance of wet, consistence of gases, protection against secondary infection, thermal insulation, elastic, perishable and bio-compatible. Wound dressings might be classified into varied varieties like matter , alginate , hydro fiber , foam , antimicrobial and colloidal gel dressings. Alginate dressings derived from seaweeds are found to be hemostatic owing to Ca++ ions therefore will be employed in trauma wounds. The particular objectives are to:-

1) Develop associate degree agent that helps in achieving fast stoppage.
2) Plan and show a flexible conveyance platform to move the wound stasis material or gel to the wound website.
3) Ensure that the astringent material used to the wound website is bio-compatible.

The main objectives behind making this wound dressing material are-

1) To heal the injured area.
2) Immobilize the lac partly.
3) Promotes damp wound healing.

Hydrogels:-

Hydrogel consists of two words hydro that means water, gel that means a state that is in between that of solid and liquid. Hydrogels seem to be cross connected networks of polymers having the capability of soaking up water and reach equilibrium. The network formation is owing to the physical and chemical linkages among the elements. Physical linkages occur owing to presence of crystalline regions or the secondary interactions like static forces, hydrophobic forces etc. whereas chemical interactions are depicted by valence bonds. the varied deliquescent polymers used embody polyvinyl alcohol, polyvinyl pyrrolidone, poly ethanediol, poly carboxylic acid, polyacrylamide etc. Hydrogels are synthesized by three strategies that embody the standard physical and chemical crosslinking and also radiation based technique of cross linkage.
The ability to keep up a 3D structural arrangement like biological tissues crystal rectifier to initial introduction of hydrogels as a biomaterial, wet wound healing studies by St. George

Winter and also the varied studies wherever it had been seen that the hydrogels had the properties of water retention, hydrophilic nature, biologically immobile, matter transport ability and Painless removal pointed towards its usage as a wound dressing. Hydrogels have conjointly been found to be fulfilling varied ideal wound dressing characteristics like rejection of open wound infections, maintenance of wet, absorption and retention of exudates, thermal insulation, and incorporation of appropriate drug, gas permeability, painless removal and higher wound monitor. Hydrogels are found to be related to weak elastic and mechanical properties. So for unraveling the matter they need been principally found to be used as composites.

Composites:-

Composites square measure materials fashioned by combination of matrix and reinforcements that not solely retain their inherent properties however, conjointly show new characteristics within the final result creating it higher than its constituting individual elements. Matrix forms continuous innovate that the reinforcements square measure spread and enclosed by matrix. A composite conjointly consists of another section known as the interphase that may be a new section fashioned attributable to combination of the matrix and reinforcements. The performance of the composite therefore fashioned is set by the degree and extent of chemical and physical forces acting between the elements helpful the point in time system. Composites may be classified on the idea of fabric of the matrix, dispersed particles kind and sort of reinforcing fibers. Based on matrix material of the composites they will be classified as metal composites, compound composites, and non-metallic materials. dispersed particles kind primarily based classification includes ceaselessly fiber bolstered composites, fibrous material bolstered composites, whisker bolstered composites, sheet bolstered composites, particle bolstered composite and nanoparticles bolstered composite. Composites with relevance reinforcing fiber sort will be divided into organic fiber, element fiber, hybrid fiber and carbon fiber.

CHAPTER 2

LITERATURE REVIEW

LITERATURE REVIEW

Wound Dressing:-

Wound healing is also a sophisticated methodology involving varied systems of our body. Wound dressing square measure used to enhance the speed of wound healing. The importance of wet healing was tested by G. Winter`s add the year 1962.Wound dressings have to be compelled to be compelled to supply positive ideal wound dressing characteristics that embrace no porosity to water and being, freedom from material, thermal insulation, absorption and retention of exudate, interference of trauma on removal, removal of deadly substances, interference of dehydration, yield vaporized exchange and painless removal of the dressing.
Hydrogels square measure found to be satisfying these ideal wound healing characteristics. Hydrogels offer a good atmosphere to dry wounds nonetheless as absorb excess exudate, betting on condition levels at the wound hydrogels. they contain varying percentages of water, but do not altogether dissolve in the water. Despite of their higher water content, hydrogels square measure capable of additionally binding nice volumes of liquid because of the presence of hydrophilic residue. Hydrogels are observed to swell extensively whereas not dynamic their jellylike structure and square measure accessible to be used as amorphous gels and in varied styles of application systems. Most hydrogels have a high water content of roughly seventieth and it's this issue that successfully promotes rehydration.

Polyelectrolyte complex:-

Polyelectrolyte complexes formation has been studied by using the dynamic syringe mixer prototype designed by us with the help of rapid prototyping for our study we had taken chitosan, calcium chloride and sodium alginate for the formation of the polyelectrolyte complex.

Background of Invention:-

An advanced hemorrhage management bandage and strategies of its application would well augment offered styptic strategies. To date, the applying of continuous pressure with cotton cloth remains the popular primary intervention technique accustomed stem blood flow particularly be due severely harm wounds. However, this procedure neither effectively nor safely stanches severe blood flow. This has been, and continues to be, a serious survival downside within the case of severe serious harm from a wound.

Furthermore, it's wide accepted that severe harm is that the leading explanation for death from wounds on the field of battle, accounting for roughly fifty % of such deaths. It’s calculable that common fraction of those deaths may well be preventable with increased hemorrhage management strategies and devices. Such increased hemorrhage management would conjointly

prove terribly helpful in non-military settings, e.g., hospitals and veterinary clinics, wherever hemorrhage is that the second leading explanation for death following trauma.

Field of invention:-

This invention is directed to hemorrhage management wound dressings, and ways of victimization and manufacturing such dressings. The topic wound dressing is made from a non-mammalian material for the management of severe hurt. The wound dressing is made of a biomaterial comprising chitosan and/or other hydrophilic polymers for dominant severe hurt. The fabric might or else comprise polyacrylic acid or a mixture of polyacrylic acid with different polymers. The type of severe hurt contemplated by this invention is of the sort which unable of being stanched once standard traditional} gauze wound dressing is applied with conventional pressure to the wound. The wound dressing is capable of well stanching the flow of severe hurt from a wound by adhering to the wound web site, protection of the wound, fast grime formation at the wound site, reinforcing clot formation at the wound web site, preventing bleed out from the wound web site, and well prohibiting the flow of blood out of the wound site.

CHAPTER 3

MATERIALS & METHODS

MATERIALS AND EXPERIMENTS CARRIED OUT:-

1) Preparation of 50ml solution containing calcium chloride and sodium alginate.
2) Preparation of different concentrations of chitosan.
3) Preparation of different stock solutions of calcium chloride.
4) Preparation of different gels by the mixing different concentrations of solutions of Chitosan + Calcium chloride and sodium alginate.

Preparation of 50ml solution containing calcium chloride and sodium alginate:-

The materials required are:-

- Calcium chloride
- Sodium alginate
- Chitosan

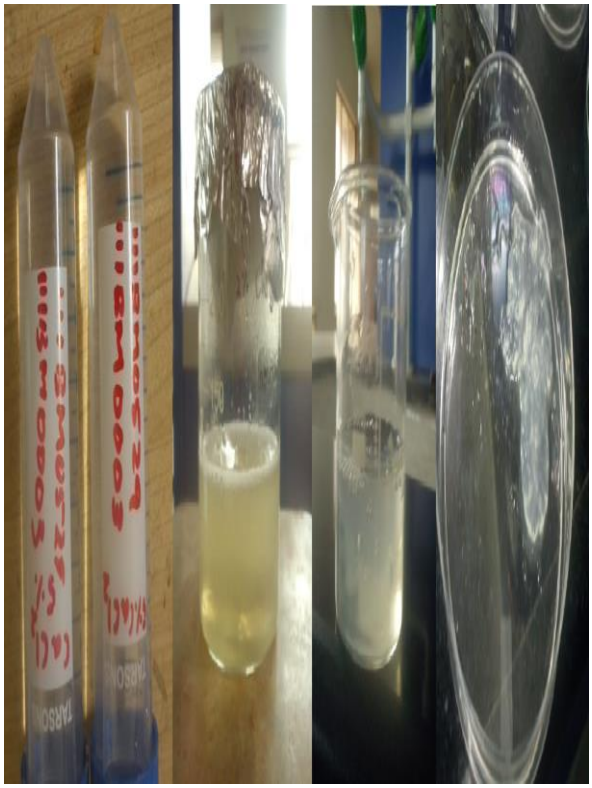
Preparation of stock solution (10mg/ml) of calcium chloride:-

calcium chloride------->+ 25 ml of distilled water------->shake---->distilled water up to 50ml ----->1% Conc. of $CaCl_2$(50ml stock soln.)

Preparation of 50ml solution containing calcium chloride and sodium alginate:-

1) From 50ml of stock solution of $CaCl_2$ we take 2 ml of $CaCl_2$ soln. in a pipette and drop into a test-tube.
2) Then 43 ml of distilled water is added to that 2ml of $CaCl_2$ soln. to get the 45 ml of soln.
3) The above setup is kept in the ultrasonic bath and 5 ml of sodium alginate solution is dropped one by one in order to get the 50 ml solution of Sodium Alginate+ $CaCl_2$.

SOLUTIONS PREAPARED:-



CHAPTER 4

RESULTS AND DISCUSSIONS

Viscosity test of the samples prepared:-

Viscometer- It's an instrument for measuring the viscosity of a fluid. It measures under conditions of one flow.

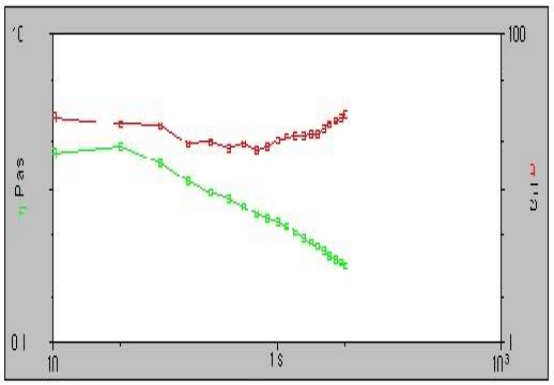
In general, the mechanism associated with the viscometer is that the fluid remains stationary and the object moves or object is stationary and fluid moves past it. The drag force which is caused by relative motion of fluid and surface is the measure of viscosity.

Viscosity test conducted for the different Sample :-

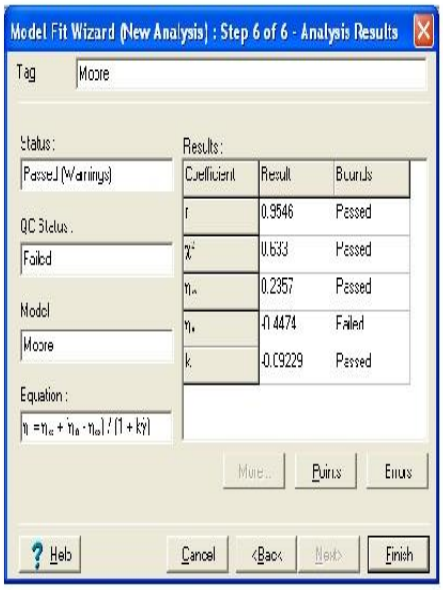
Sample 1:- (chitosan+ calcium chloride) + sodium alginate [1:1 ratio]
Sample 2:- (chitosan+ calcium chloride) + sodium alginate [1:2 ratio]
Sample 3:- (chitosan+ calcium chloride) + sodium alginate [1:3 ratio]
Sample 4:- (chitosan+ calcium chloride) + sodium alginate [2:1 ratio]
.

Viscosity graphs:-

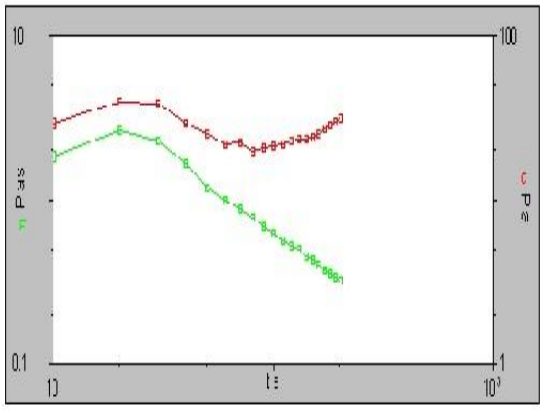
Sample 1:- (chitosan+ calcium chloride) + sodium alginate [1:1 ratio]

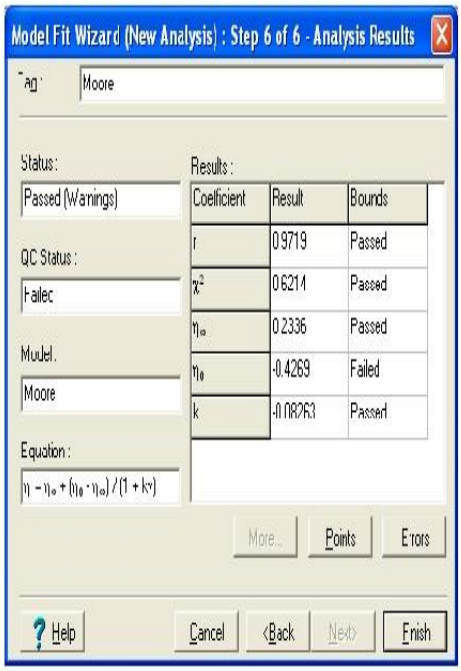


Shear Rate	Phase Ang	Strain	Viscosity I	Eta Doubl	Dynamic \	Complex \	Notes
17.11			1.669				
14.05			1.857				
17.28			1.458				
17.28			1.107				
21.45			0.9264				
21.41			0.836				
25.6			0.7508				
25.61			0.6795				
29.79			0.6223				
33.89			0.593				
38.06			0.5559				
42.23			0.5131				
46.39			0.4682				
50.55			0.4396				
54.73			0.4123				
63.14			0.383				
71.47			0.359				
79.79			0.3397				
88.12			0.3231				
96.51			0.3089				



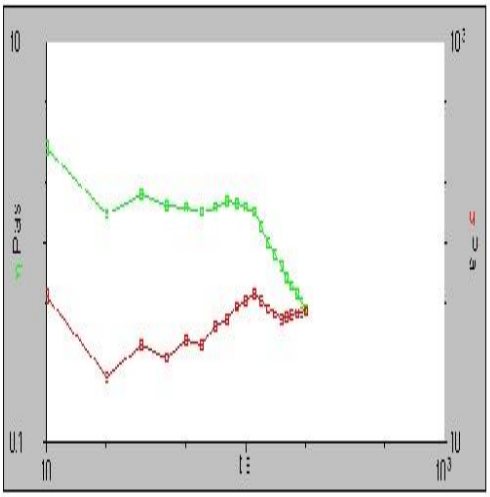
Sample 2:- **(chitosan+ calcium chloride)+ sodium alginate [1:2 ratio]**



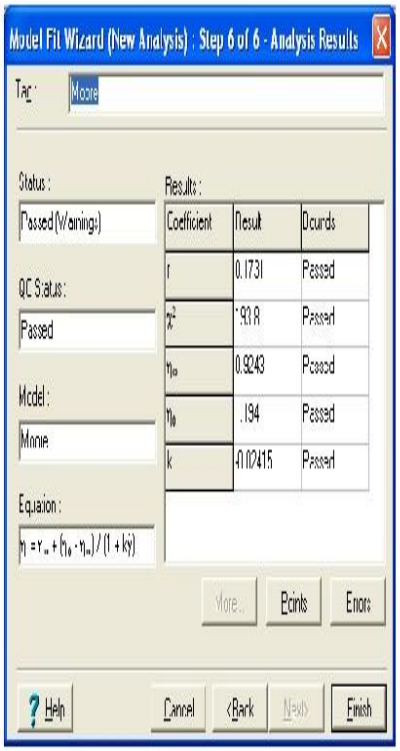


Shear Rate	Phase Ang	Strain	Viscosity I	Eta Doubl	Dynamic \	Complex \	Notes
15.99			1.786				
15.04			2.588				
17.29			2.223				
17.35			1.647				
21.47			1.152				
21.5			0.9868				
25.63			0.8571				
25.66			0.7584				
29.94			0.6774				
33.92			0.6113				
38.04			0.5638				
42.21			0.521				
46.43			0.4897				
50.64			0.4526				
54.83			0.423				
63.22			0.394				
71.55			0.3717				
79.81			0.3509				
88.22			0.3336				
96.61			0.318				

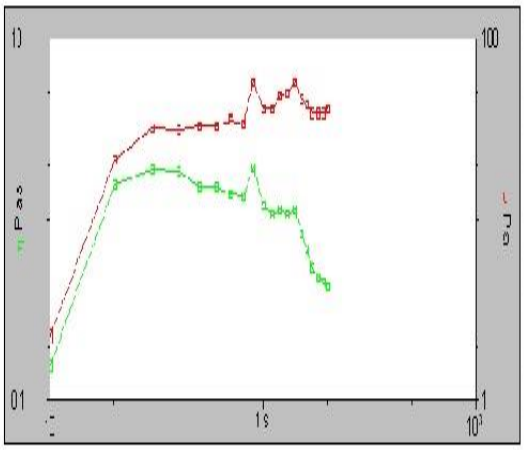
Sample 3:-



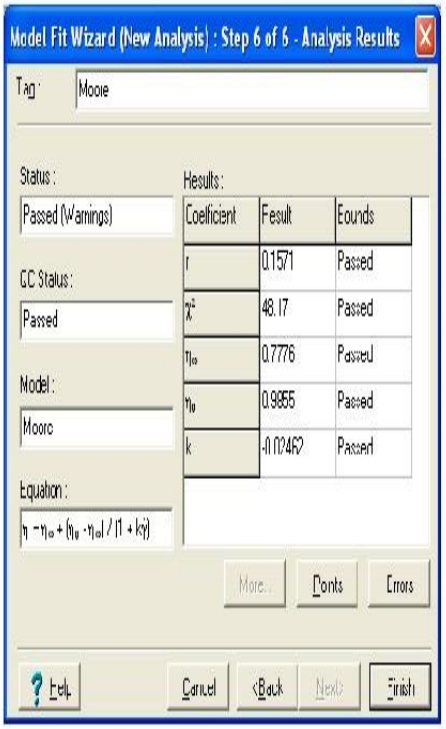
Shear Rat	Phase Ang	Strain	Viscosity I	Ete Doubl	Dynamic V	Complex V	Notes
17.83			2.947				
15.33			1.363				
17.73			1.714				
17.48			1.503				
21.66			1.466				
21.44			1.422				
25.62			1.479				
25.62			1.603				
29.83			1.566				
33.93			1.485				
38.1			1.412				
42.27			1.196				
46.44			0.9831				
50.63			0.8552				
54.78			0.75				
63.17			0.6623				
71.52			0.5926				
79.83			0.5439				
88.18			0.4957				
96.55			0.4601				



Sample4:-



Shear Rat	Phase Ang	Strain	Viscosity	Eta Doubl	Dynamic \	Ccmplex \	Notes
14.53			0.1522				
13.79			1.541				
17.3			1.883				
17.3			1.835				
21.49			1.529				
21.43			1.528				
25.6			1.389				
25.59			1.33				
29.62			1.915				
33.93			1.172				
38.07			1.062				
42.24			1.12				
46.41			1.049				
50.54			1.119				
54.76			0.8235				
63.15			0.6707				
71.44			0.5311				
79.83			0.4738				
88.12			0.4388				
96.53			0.4143				



FTIR CHARACTERIZATION TECHNIQUE:-

Aim:–FTIR analysis of the samples.

Requirements- 1) fresh samples of (Chitosan+ Calcium Chloride)+sodium alginate with 1:1 ratio, 1:2 ratio and 1:3 ratio.

Principle-

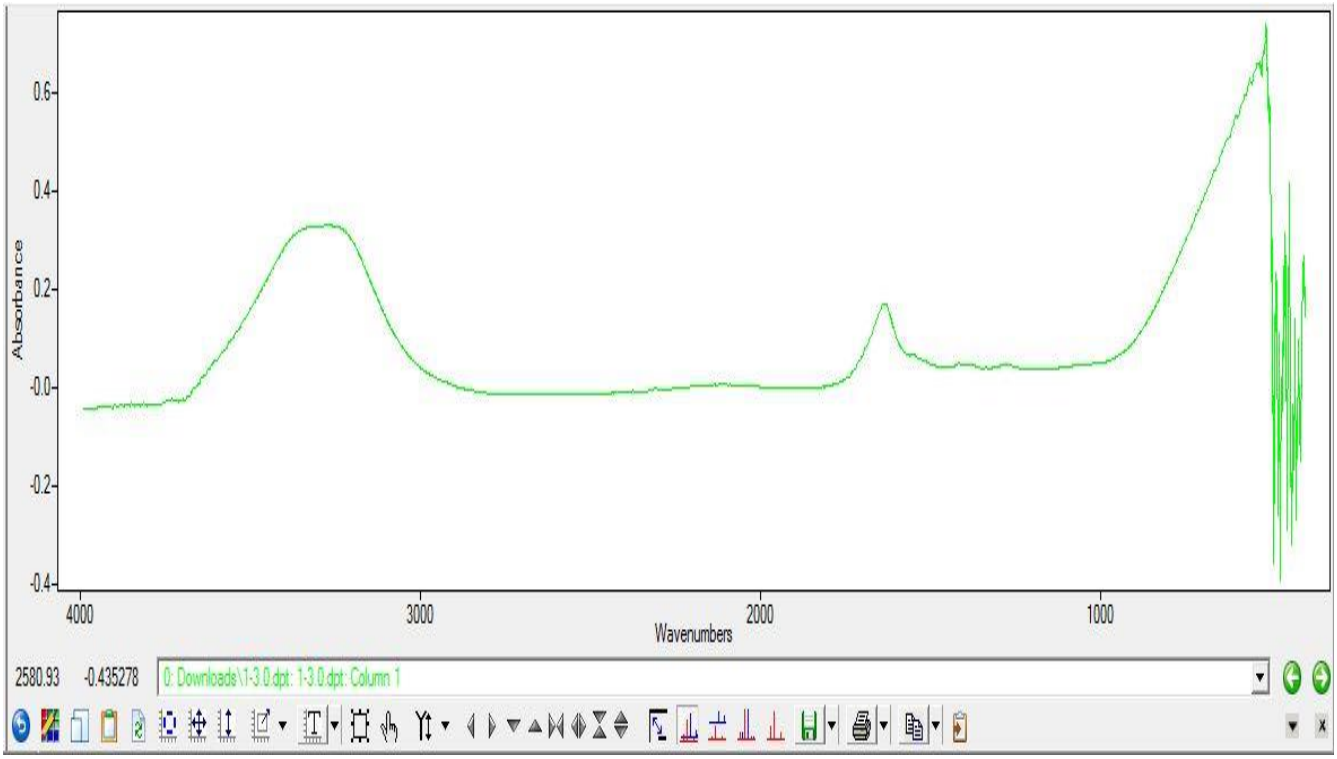
Fourier Transform Infrared Spectroscopy is a technique which is used to obtain an infrared spectrum of absorption, emission, photoconductivity and Raman scattering of solid, liquid and gases. An FTIR spectrometer simultaneously collects spectral data in given spectral range. This confers a significant advantage over a defensive spectrometer which measures intensity over a narrow range of wavelength at a time. The term Fourier infrared spectroscopy originates from the fact that a Fourier transform is required to convert the raw data into actual spectrum. We are observing the samples in ATR FTIR process.

Observation-

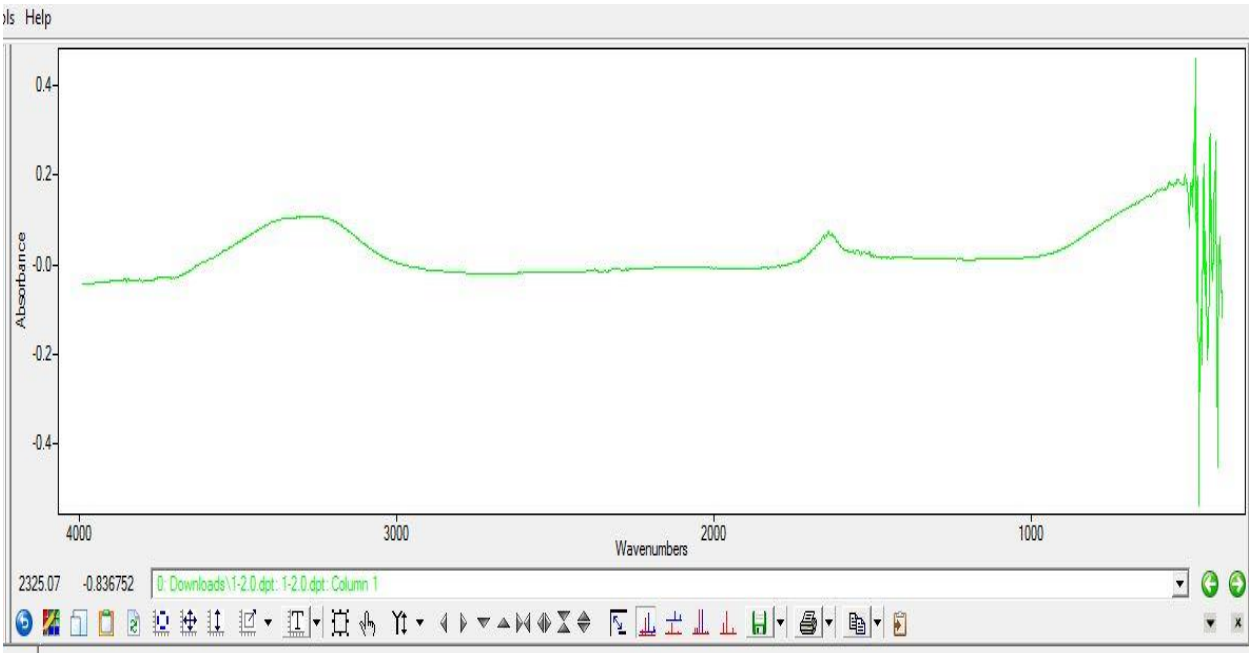
The graphs obtained for the samples are plotted and analysis of the obtained graph was done.

FTIR ANALYSIS OF THE SAMPLES PREPARED WAS STUDIED:-

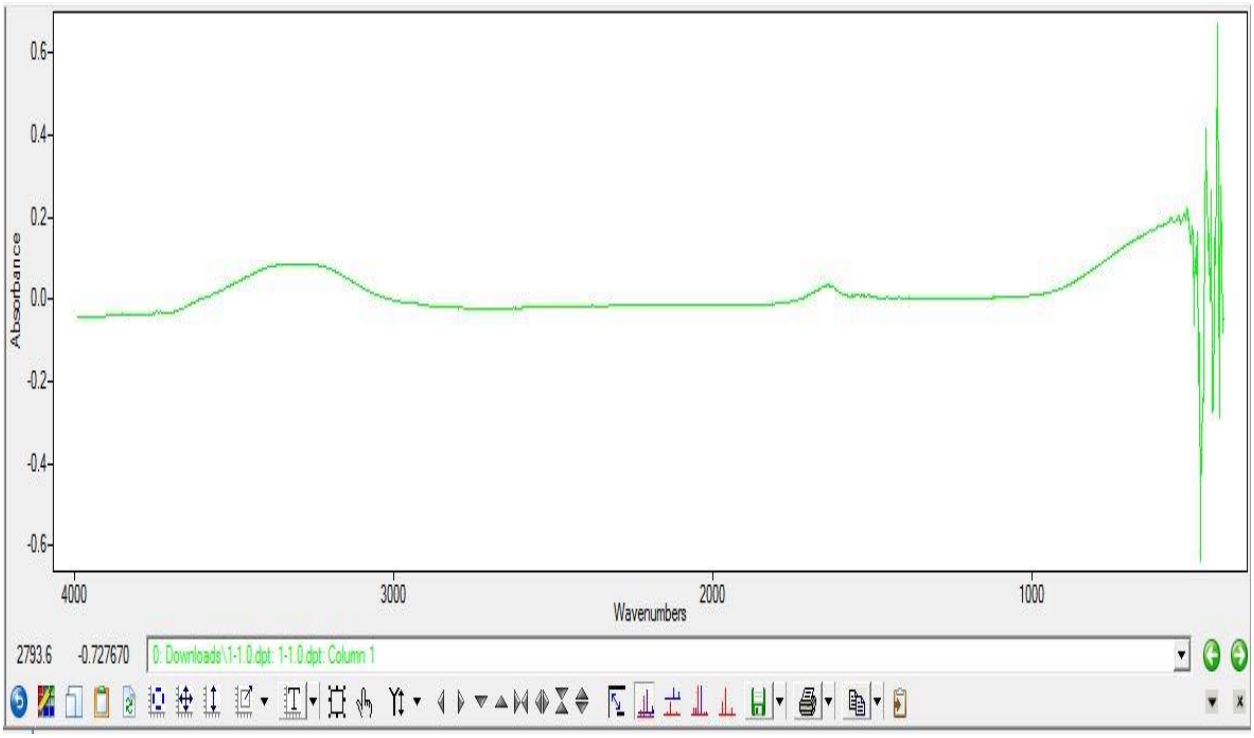
Sample 1:- (chitosan+ calcium chloride) + sodium alginate [1:1 ratio]



<u>Sample 2</u>:- (chitosan+ calcium chloride) + sodium alginate [1:2 ratio]



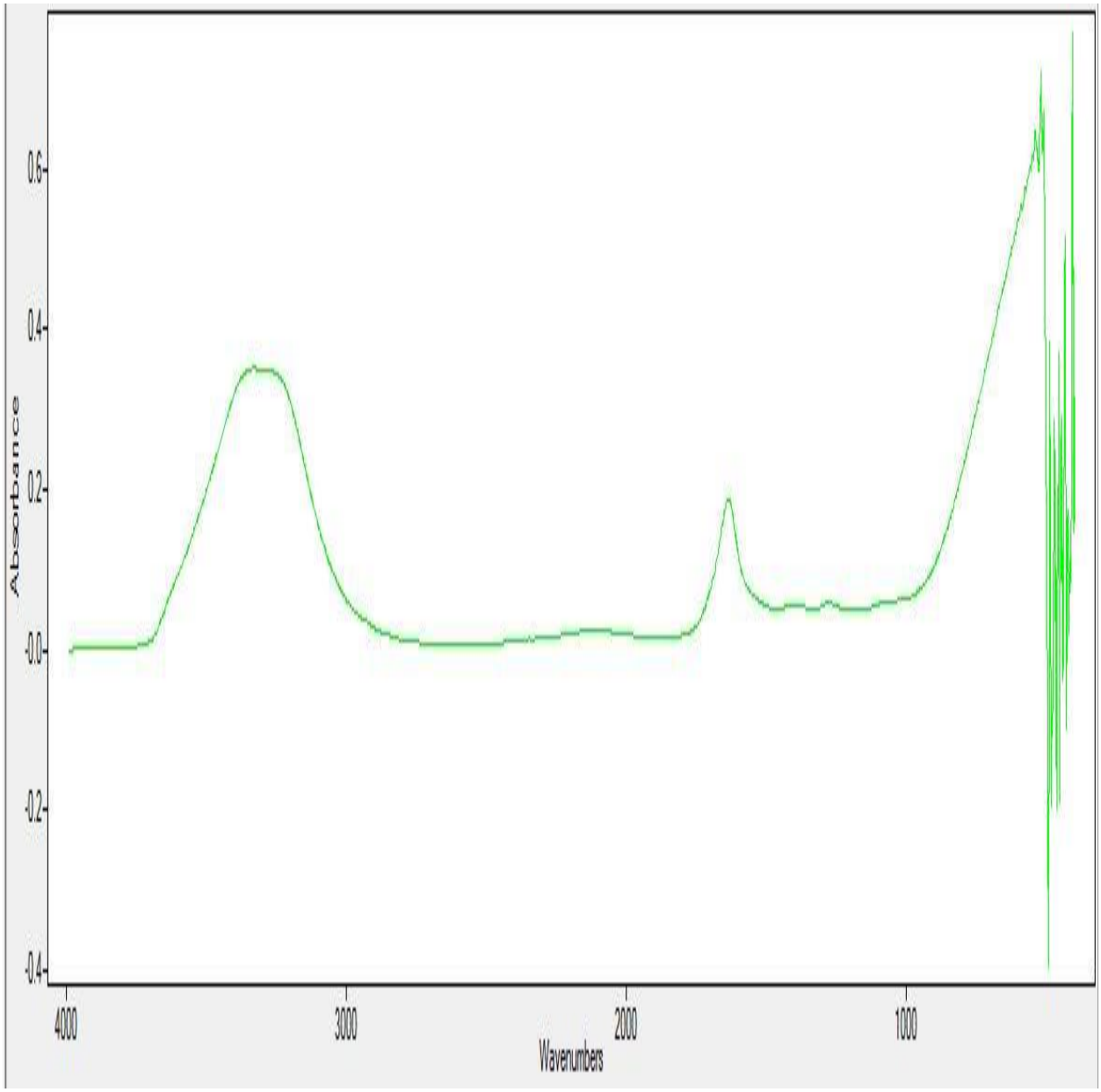
<u>Sample3</u>:- (chitosan+ calcium chloride) + sodium alginate [1:3ratio]



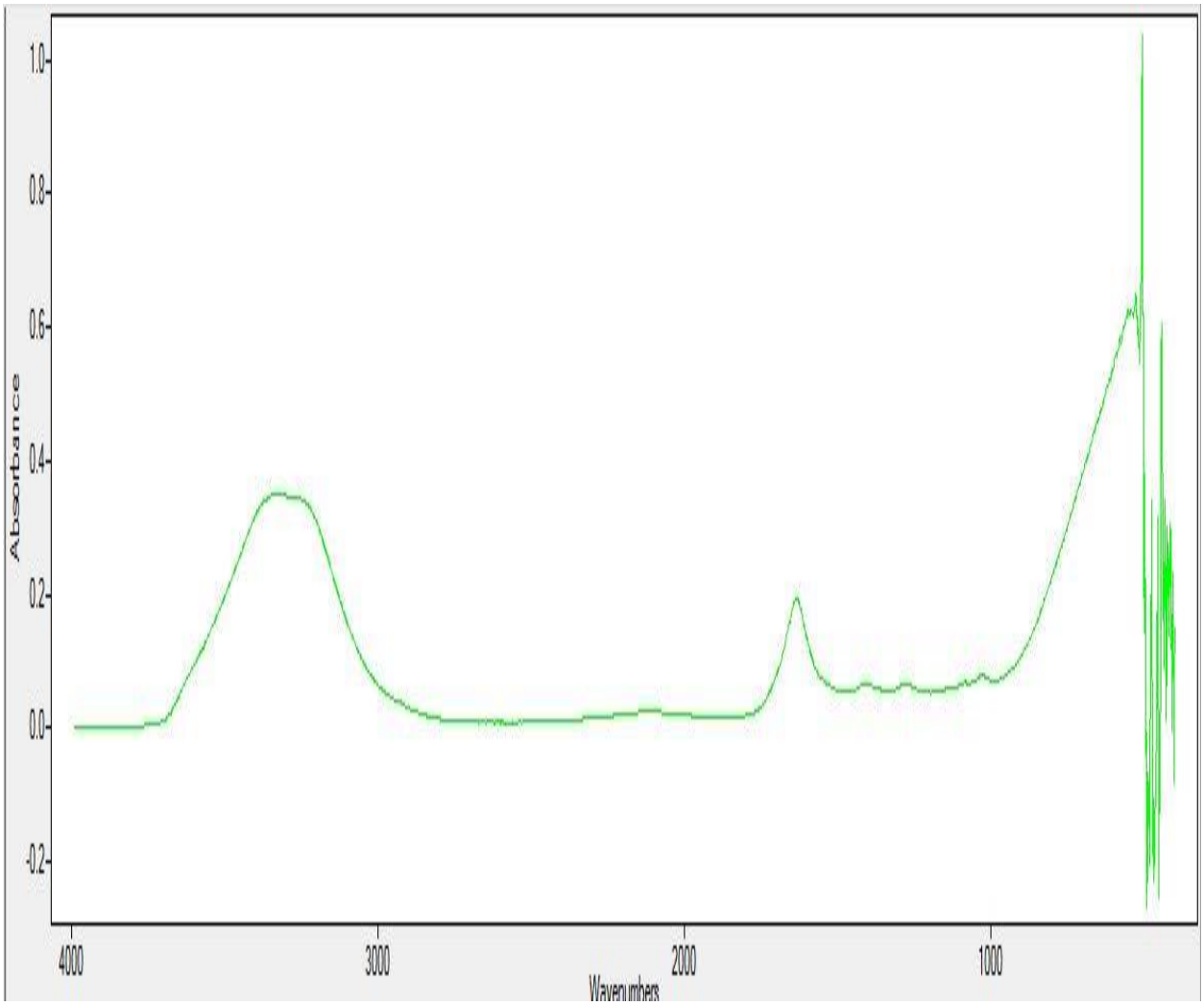
FTIR ANALYSIS OF THE SAMPLES:-

With different Concentration of Calcium Chloride.

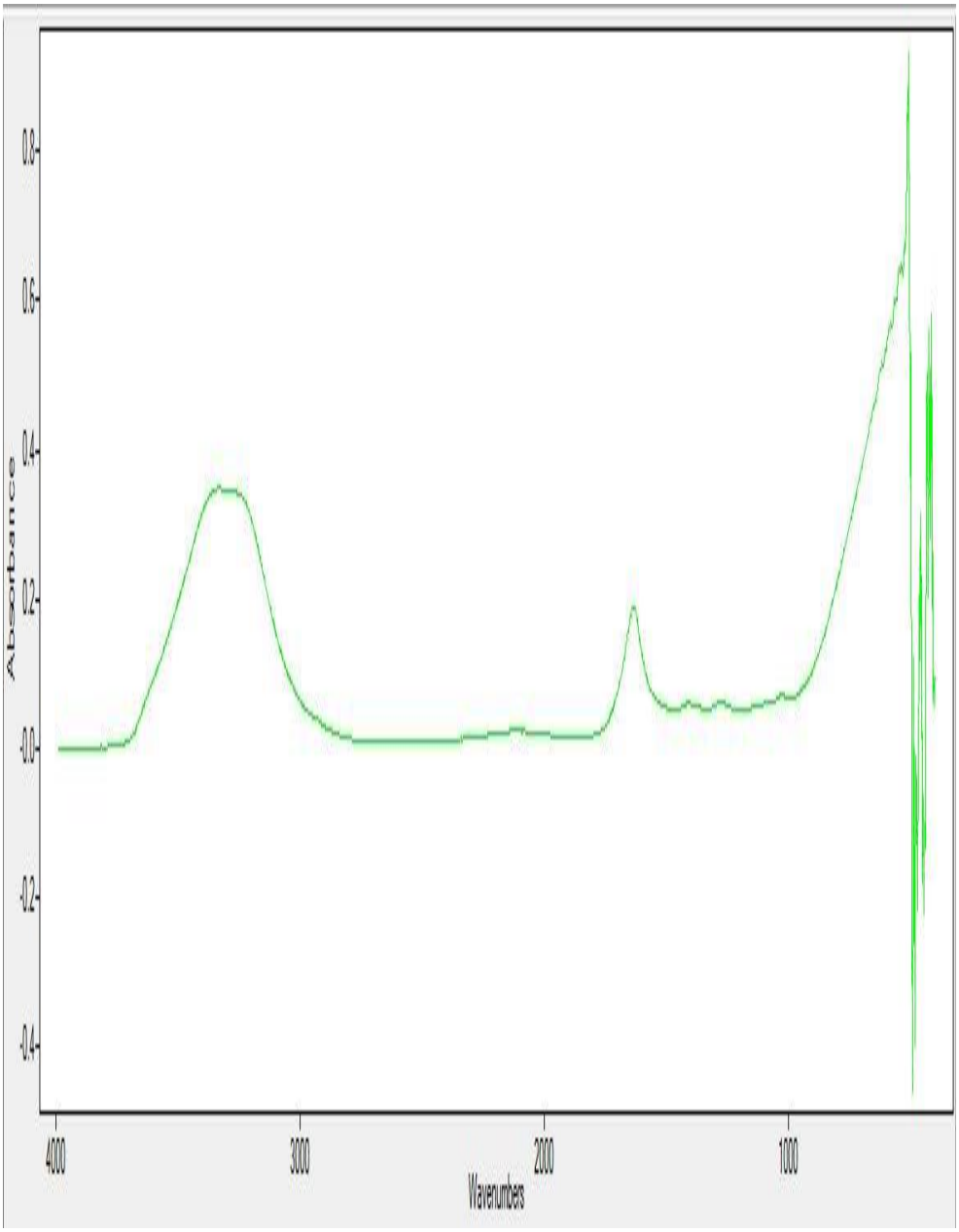
Sample 1:- (chitosan +calcium chloride) + Sodium Alginate [1:1 ratio] [12% conc. Of $CaCl_2$]



<u>Sample 2</u>:- (Chitosan +Calcium Chloride) + Sodium Alginate [1:2 ratio] [15 % conc. of $CaCl_2$]



<u>Sample 3</u>:- (Chitosan +Calcium Chloride) + Sodium Alginate [1:3 ratio] [20% conc. of $CaCl_2$]



Dynamic Syringe Mixer:-

Our aim is to develop a simple and a versatile dynamic syringe mixer which helps in homogeneous mixing of the chitosan plus calcium chloride solution with the sodium alginate solution. The dynamic mixer is designed in such a way which minimizes the gelation of the mixing solutions by the injection of the two solutions through two convenient passages while the mixing occurs in a common chamber which contains the rotating platforms and the gel thus formed comes out through the nozzle of the chamber to be applied on the wound site.

Modeling of dynamic syringe mixer by Catia v5 r21:-

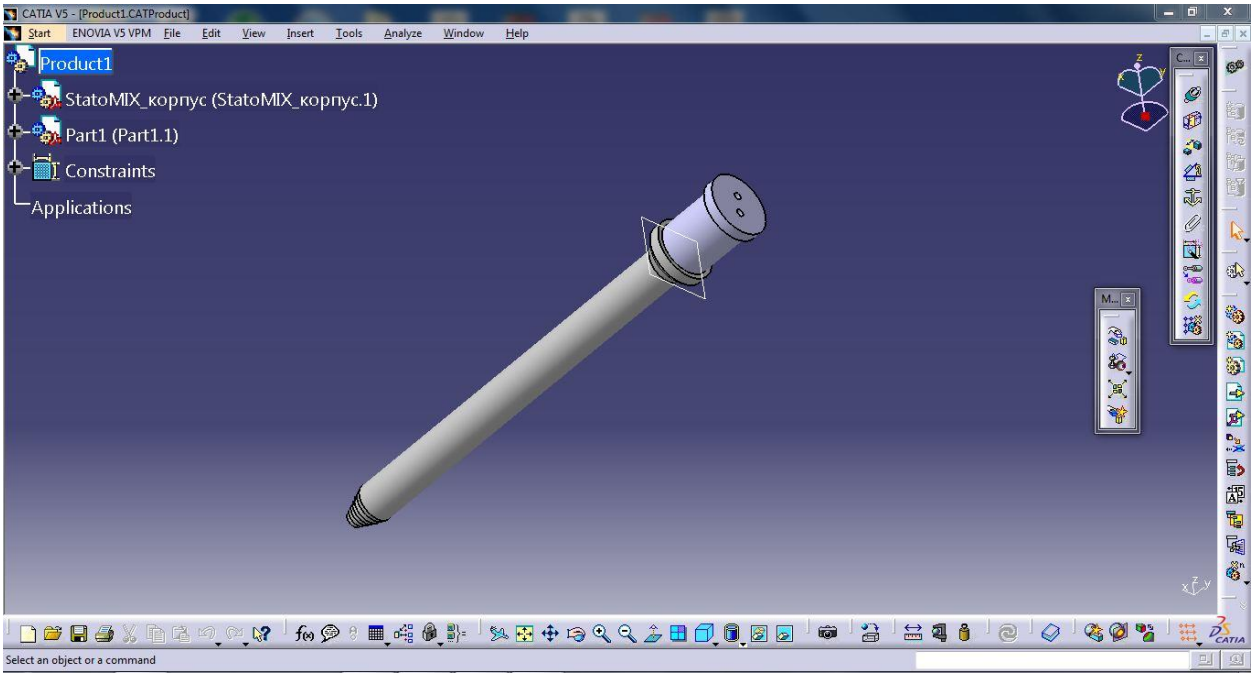
Aim: - To design a prototype of a dynamic stirrer mixer.

Software: – Catia v5 r21

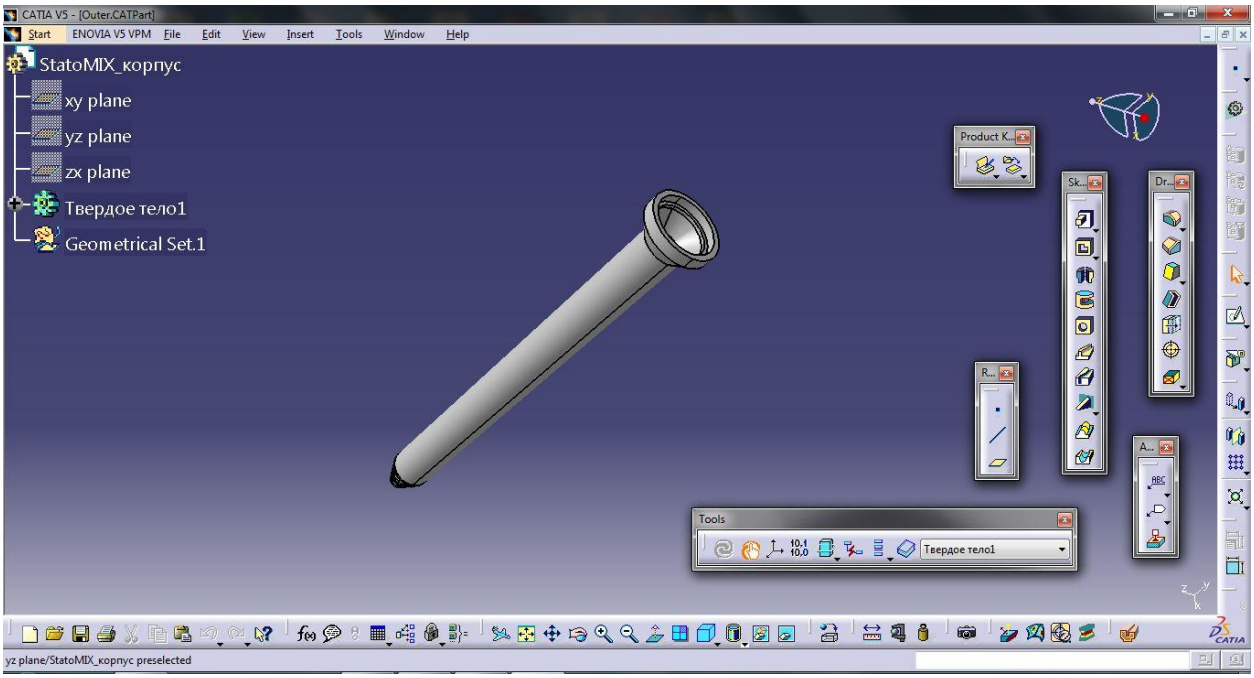
Theory: - The 3D model of the dynamic stirrer mixer is made on the part design workbench of the Catia. The stirrer consists of 3 major components; - part 1 is the top part which consists of two passages through which solution can be injected with the help of syringe. The 2nd part is the lower part which consists of rotating platforms; the solution injected enters the 2nd part where mixing process starts.

Design of the dynamic syringe mixer:-

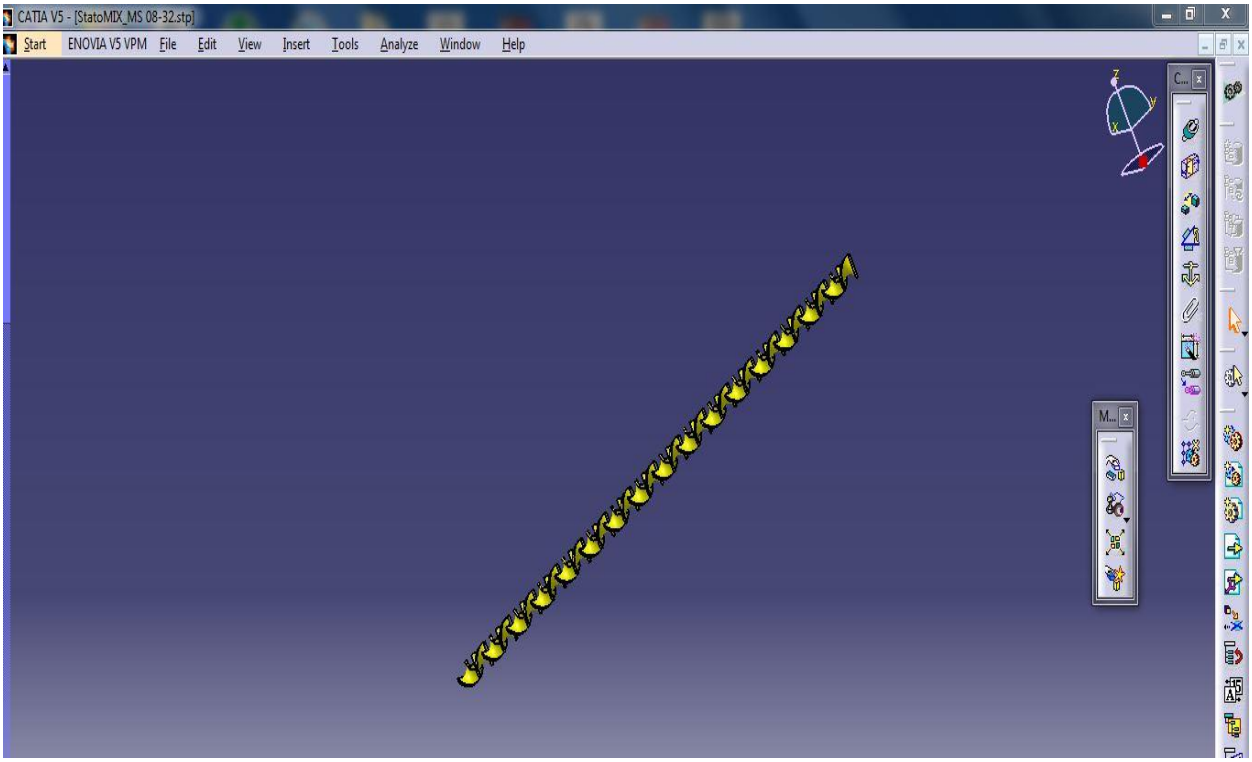
Top part-



Bottom part-



Rotating platform-



Rapid prototyping:-

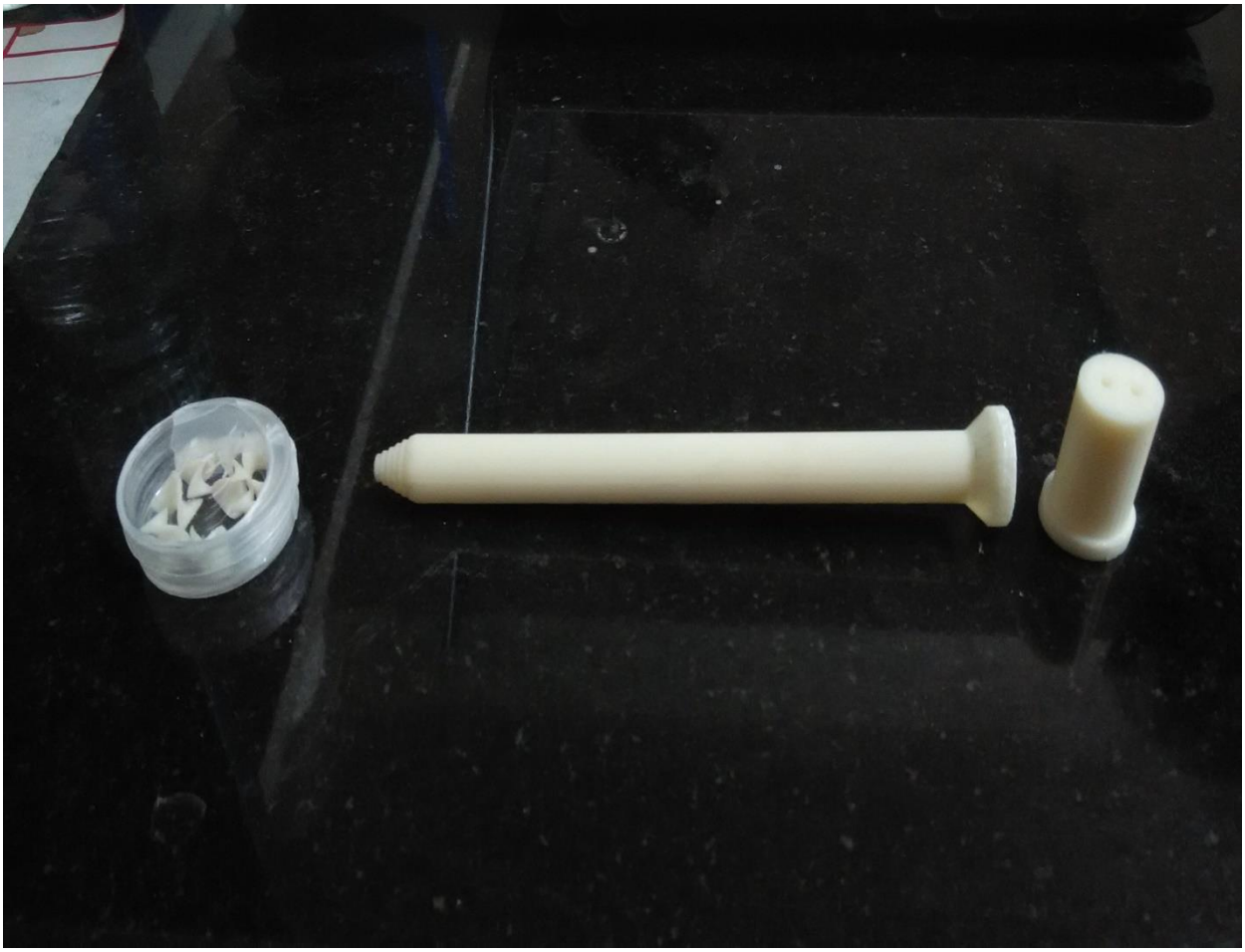
Aim-To model the prototype design of the dynamic stirrer mixer using rapid prototyping

Material –RP machine fortus 400mc, abs m30.

Theory – Rapid prototyping is a technique which is used for fabricating a part of a model of a physical element by using 3D computer aided design. The construction of the assembly is done by 3d printing or by the use of "additive layer manufacturing technology".

Procedure- The ".stl" file of the 3 parts was given for the rapid prototyping.

DYNAMIC MIXER AFTER RAPID PROTOTYPING:-



Top part, bottom part and rotating platforms:-

CONCLUSION

From the above experiments carried out by us concludes that for the gel to be formed and for its application as a wound dressing, proper mixing should be allowed and the prototype designed by us minimizes the time of formation of the gel when the solutions are mixed and serves as platform for the application near the wound healing.

Also the FTIR analyses of the samples were studied and we could predict from the graphs which sample is good for using as a wound dressing material. While varying the conc. of the calcium chloride in the samples prepared the FTIR graphs were same for each of the samples. The viscosity tests of the samples were carried out and were analyzed. By using the dynamic syringe mixer we tried to form the gel which showed that homogeneous mixing can be achieved by using this syringe mixer.

REFERENCES

1) Polyelectrolyte complex composed of chitosan and sodium alginate for wound dressing application by Yun-Jung Kim[a], Hyun-Chul Lee[b], Jong-Suk Oh[c], Boo-Ahn Shin[d], Chang-Seokoh[e], Ro-Dong Park[f], Kap-Seung Yang[g] & Chong-Su Cho[h], pages 543-556.

2) Chitosan and alginate polyelectrolyte complex membranes and their properties for wound dressing application by Xin Meng ,Feng Tian , Jian Yang, Fan Li .pages 1-6 J Mater Sci.

3) Heather L. Orsted and D.K., Louise Forest Lalande, Marie Françoise Mégie, *Basic Principles of Wound Healing.* Wound Care Canada, 2004. **9**(2): p. 4-12.

4) Abdelrahman, T. and H. Newton, *Wound dressings: principles and practice.* Surgery (Oxford), 2011. **29**(10): p. 491-495.

5) Koo, J.H., *Polymer nanocomposites*. 2006: McGraw-Hill Professional Pub. New York.

6) Hemostatic wound dressing patent US 5836970 A.

7) Rapid prototyping from www.emeraldgrouppublishing.com

8) Corkhill, P.H., C.J. Hamilton, and Tighe, B.J., *Synthetic hydrogels VI. Hydrogel composites as wound dressings and implant materials.* Biomaterials, 1989. **10**(1): p. 3-10.

9) Kickhöfen, B., Wokalek, H., Scheel, D. and Ruh, H., *Chemical and physical properties of a hydrogel wound dressing.* Biomaterials, 1986. **7**(1): p. 67-72.